ories of that beautiful and quiet English countryside which is associated with the name of the botanist who of all the early botanical explorers in California makes the strongest appeal to our scientific understanding and to our intellectual sympathies.

SOME OBSERVATIONS ON TWO SPECIES OF ARCTOSTAPHYLOS

J. E. Adams

On the occasion of a visit to the type locality of Arctostaphylos myrtifolia and Arctostaphylos viscida, at Ione, Amador County, the writer was impressed by the generally unhealthy appearance of the chaparral growth on the low ridges east and southeast of the town, where it consists wholly of Arctostaphylos represented by the two above-mentioned species largely, and a very few individuals of Arctostaphylos manzanita. In these areas the ground is thickly strewn with bleached, dead stems and branches which show the peculiar flattened or ribbon-like form commonly associated with Arctostaphylos myrtifolia. The plants are exceedingly scraggly and distorted, and practically all bear many dead stems still attached to the root crown. Even the old living stems of most of the plants are deformed, bleached, and dead-looking at first glance. The absence of indications of fire damage led to a closer examination of these stems. Interestingly enough, it was found that the peculiar flattening of the stems is not at all confined to Arctostaphylos myrtifolia, but is quite general among the individuals of Arctostaphylos viscida in the region. Indeed, dead, detached stems of equal size of the two species can scarcely be distinguished. The following observations, then, apply generally to the phenomenon in both Arctostaphylos myrtifolia and viscida.

The ribbon-like development does not appear as though brought about by simple lateral compression of an otherwise normal stem, as would be inferred from the usual description, but, on the contrary, appears to be of a pathological nature. The dead stems appear to have suffered a gradual but complete decortication which seems to bear a direct relationship to the ribbon-like development. Old living stems show the peculiar flattening for a greater or smaller portion of their length mostly near their bases, and at first glance appear no different from the quite dead stems, although bearing green foliage. Closer examination of such members, however, reveals a narrow strip of living red bark along one edge only, while the greater portion of the surface is bleached and dead-looking. Generally the more pronounced the flat development, the narrower is the strip of living bark. The narrow strip of bark is underlain by a strip of

white sapwood. The bleached surface represents bare, desiccated wood, or in places this may support a crustaceous lichen-growth. The wood below such exposed surfaces is dark brown or reddish.

Younger branches of old individuals and the stems of young plants have not been observed to show this ribbon-like development, being generally terete. They do, however, show certain features which are thought to be related, to it, and which will be described below. Also, a few plants of Arctostaphylos myrtifolia growing isolated from the main groups and appearing vigorous and healthy, possess only normal, fully corticated, terete stems and branches. This peculiar ribbon-like development has

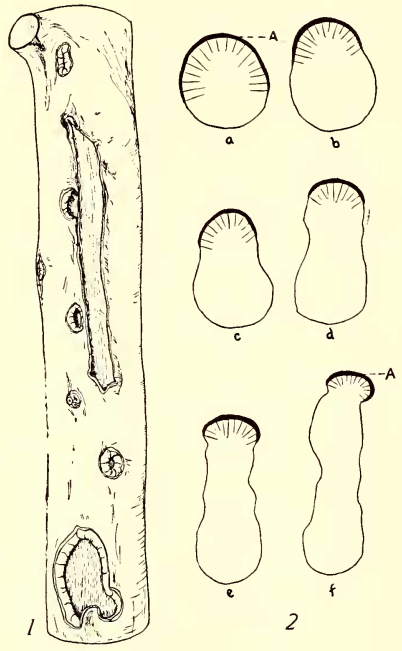


Fig. 1. Young branch of Arctostaphylos viscida with lesions at various stages.

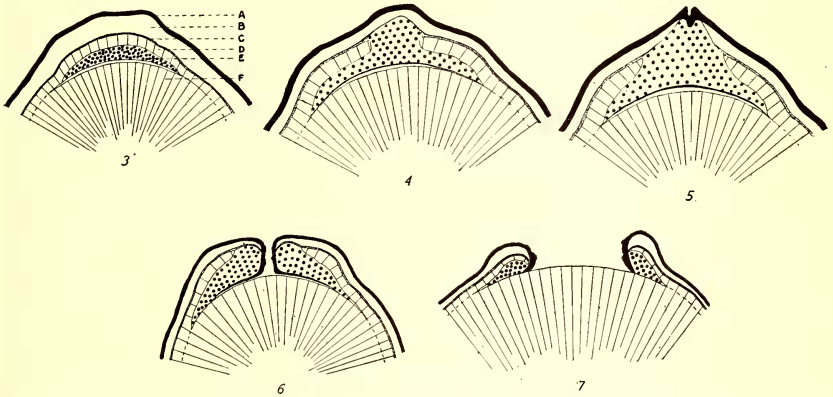
Fig. 2. Diagrams of sections of branches of Arctostaphylos myrtifolia, showing stages in ribbon-form development; extent of living bark, A; remainder, desiccated wood.

not been observed by the writer in Arctostaphylos viscida in other parts of its range.

Examination of the young, normally terete and fully corticated branches of Arctostaphylos myrtifolia and viscida and many of the stems of young individuals in the region, reveals a series of features which appear to be related to the decortication, peculiar ribbon-like development, and eventual death of the older branches and stems.

At various points toward the distal end on young stems and branches, there appear very small pustulous excrescences. These

small raised points are at first covered by smooth bark which appears eventually to break as the swelling increases, forming a very small linear lesion, about one line in length, around which the bark thickens slightly and becomes rough. The bark then gradually recedes from the point of initial break, producing a lesion generally elliptical and parallel with the axis, or varying to round or irregular. The receding bark exposes an area of wood, which, due to dessication, assumes a grayish, bleached color. The margin of these lesions continues to be rough and thickened as the bark recedes. This gradual recession of the bark and exposure of underlying wood proceeds rapidly in both directions along the axis, and more slowly around the circumference. A single lesion in a clear expanse of bark may thus give rise to an extensive denuded area; lesions arising in close



Figs. 3–7. Semi-diagrammatic drawings of lesion development in Arctostaphylos viscida. A, cork; B, phloem and cortex; C, cambial layer; D, current year's wood; E, callous growth; F, older wood. (Note break in periderm in Fig. 5; incipient recession of bark in Fig. 6; exposure of deeper wood beneath older lesion in Fig. 7).

proximity to one another may coalesce to give still larger decorticated areas. Thus the continued recession of bark exposes a large and larger surface of wood which promptly assumes the ashen color, and the extent of the living bark is eventually reduced to a narrow strip as the receding margins approach each other around the stem.

Meanwhile, however, cambial activity is proceeding normally in the healthy areas, producing new wood beneath and thus tending to raise the healthy areas considerably above the level of the originally exposed wood layer. In old lesions on a large stem this tends to produce deep furrows, at the base of which can be seen the first-exposed wood. In stems and branches of smaller size the continued growth of a narrow, healthy strip of bark along one side would clearly give rise, after a time, to

the peculiar flattened form. The relatively slower recession of the bark circumferentially would thus permit of a considerable one-sided development before death of the stem occurs, apparently by complete girdling, or a process amounting to that. The lateral spread of the decorticated area does not appear to be uniform at all points in extensive lesions, so that complete girdling may be effected at a lower point in the stem while the decorticated area at the upper end of the lesion may extend, for example, only one-quarter the way around the circumference. Thus most of the dead stems, attached and detached, are extremely flattened for some distance near the bases and gradually become terete toward the ends. The wood of completely dead

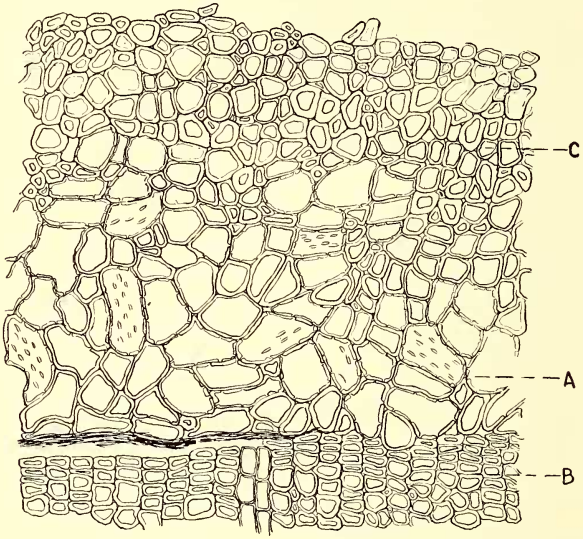


Fig. 8. Arctostaphylos myrtifolia. Section through incipient lesion, showing nature and extent of callous, A, with reference to old, B, and new, C, wood. (Camera lucida.)

branches which is not too weathered and that underlying the denuded areas appear to be sound and to have suffered no injury except desiccation and starvation resulting from decortication and girdling. Neither the surface nor deeper layers of the exposed wood appear to have decayed.

It is not the intention of the writer to delve into the pathology of the condition, but some observations on the histology of the structures involved, and suggestions therefrom may be of interest. Cross sections through the young pustules, or incipient lesions of young affected stems show normal intact bark raised slightly above the general surface so as to form a slight swelling or point. In material collected late in March a few to several cell-layers of this year's annual ring of wood immediately below

the distended bark are arched outward and thus follow the contour of the surface. This wood is sharply separated from the deeper layers by the interposition of a mass of large, thick- and porous-walled cells, which in turn is sharply delimited from the deeper wood by a well-defined line or break at the outer margin of last year's wood.

The circumferential extent of the interposed group of cells and of the line or break separating it from the deeper wood is about equal to or greater than the diameter of the pustule as seen in surface view. Radially, the interposed group is equal in extent to approximately the height of the pustule above the general surface of the stem. The line delimiting the interposed tissue from the underlying wood is generally dark in color, and where an actual break separates the two tissues, the cells immediately bordering the space on its outer margin are commonly brown and appear corky. The interposed tissue then appears to increase in radial and circumferential extent, accompanied by a break in the layers of wood and the bark above it, its own mass dividing radially into two parts. A narrow channel is thus created, extending from the underlying wood to the surface. The cells lining this channel become suberized. The two receding edges are thus capped by corky cells which extend inward to the break below the interposed tissue and continue circumferentially for a short distance along its inner margin. Although it appears probable that wound tissue is attempting to close these lesions, it is indicated by the nature of the wound and of the deformity that the healing process is defeated by the recessionary process.

The nature of the causative agent raises several questions. Sunburning does not recommend itself because of the nature of the wound, and species of the genus in other regions are equally exposed, yet do not show the condition, so far as observations go, and stems more or less continually shielded from the hot sun show the injury as frequently as strongly insolated members. It is supposed, however, that once the lesion is formed, desiccation may be a factor in the course and extent of the damage. It is observed that the flattened stems of Arctostaphylos myrtifolia which are prostrate upon the ground root freely at various points from the narrow strip of living bark generally on the underside. Otherwise, in both species the position of the living bark is not constant in relation to sun-exposure.

The nature of the condition at first suggested a parasite, possibly a fungus or bacterium, but microscopic examination of the tissues has revealed no organized parasite.

The position of the interposed tissue or callous-like growth invariably at the outer limit of last year's growth of wood may indicate that the initiating injury occurred after the cessation of growth in the fall and before the resumption of growth in the

spring. The over-arching wood represents the growth of the present year, produced by the active cambium simultaneously with the growth of the callous. The surface of the pustule shows no evidence of external mechanical injury, although it is very possible that extremely small insect punctures would escape detection. The very local occurrence of the condition would, however, seem to argue against the possibility of insect injury.

The presence of the pronounced line or break below the callous growth may be significant. The line or break appears to increase along the margin of the annual ring of wood slightly in advance of the callous. Any given break, once established at the margin of a wood layer, continues only along that margin. The process might thus be likened somewhat to checking, toward which the wood shows a pronounced tendency. Thus the separation of the layers of wood may serve as a secondary injury-stimulus to the further production of callous.

These suggestions are offered merely as interesting possibilities in the etiology of this peculiar condition. The writer is not prepared to undertake a detailed pathological study now. In the present connection, it is perhaps sufficient to emphasize that the peculiar ribbon-like development of the stems, well-known in Arctostaphylos myrtifolia, is clearly a pathological condition, manifest in its characteristic form only in later life. Its occurrence in many, but not all, individuals of the species, as well as its occasional occurrence in Arctostaphylos viscida, render untenable its use as a reliable systematic character.

University of California, Berkeley, July, 1934.

MARCUS EUGENE JONES

Caught in one of the numerous traffic accidents which prevail upon the public roadways of California, Marcus E. Jones was killed at San Bernardino on June 3, 1934, at the age of eighty-two. Born at Jefferson, Ashtabula County, Ohio, on April 25, 1852, his family moved during his late childhood to a farm in Iowa, where he later took a bachelor's and a master's degree at Iowa (Grinnell) College. The greater portion of his adult life he lived at Salt Lake City and had employment at a kind of mine inspection, a work which took him on many journeys over the Great Basin region and more or less throughout the Pacific portion of the United States. While on these travels he assiduously collected the native seed plants "on the side" and built up a large herbarium, doubtless the most valuable that has ever been made for the Great Basin. At the same time he acquired a field knowledge of the flora which enabled him to recognize and publish many species from western America, of which many have been well sustained. His "Contributions to Western Botany" comprise eighteen papers; the larger number of which with much